



TECHNOLOGY

INNOVATION

NASA'S MAGAZINE FOR BUSINESS & TECHNOLOGY



LIFE BEYOND EARTH: A Vision for the Future

PLUS

Video-Enhancing System Helps Law Enforcement
2004 Space Technology Hall of Fame Inductees
LEDs Provide Help for Cancer Patients



Upcoming Events

Oct. 5-7: Southeast Technology Expo, Research Triangle Park, N.C.

Twenty-four leading universities and research labs from across the southeastern United States will feature emerging research and technologies of interest to industry partners.

Contact Susan Brown at 919/541-7401 or seb@rti.org.

Sponsorship opportunities are available.

Oct. 19: KSC Business Expo, Cape Canaveral, Fla.

The annual trade show sponsored by NASA/Kennedy Space Center Small Business Council, 45th Space Wing, and Canaveral Port Authority will feature more than 175 businesses and government exhibits.

<http://expo.ksc.nasa.gov/>

Contact Gloria Marsh at 321/867-7353 or e-mail her at

Gloria.Marsh-1@nasa.gov.

Oct. 30-Nov. 5: CANEUS 2004, Monterey, Calif.

CANEUS 2004 is the world's premier international conference devoted to Micro-Nano-technology (MNT) development for aerospace applications.

The conference brings together key scientists, engineers, program managers, investors and policymakers from America, Europe and Asia, representing both the MNT development community and aerospace end users.

<http://www.caneus.org/CANEUS04/index.shtml>

Nov. 11-12: NASA Nano2004, Baltimore, Md.

The premier event for emerging business opportunities in nanotechnology explores real-world applications in key market segments including aerospace/defense, biomedical technology, power and energy, electronics and environmental and safety.

<http://www.techbriefs.com/nano>

COVER STORY

PAGE 8



LIFE BEYOND EARTH: A VISION FOR THE FUTURE

NASA's Vision for Space Exploration will bring great discoveries and benefits to all mankind with the help of its industry partners.

feature articles

18



VIDEO-ENHANCING SYSTEM PUTS CRIMINALS BEHIND BARS

VISAR's technology has made a tremendous contribution to the homeland security initiative.

23



2004 SPACE TECHNOLOGY HALL OF FAME

New inductees are recognized for technologies that bring to Earth a different life-enhancing benefit from space.

26



LEDs ENHANCE QUALITY OF LIFE

Light-emitting diodes relieve discomforts associated with the treatment of cancer.

departments

To view online and for past issues, visit
<http://www.ip.hq.nasa.gov>.



PAGE 5

NEWS BRIEF: MAGNETIC SCANNER IMPROVES BUSINESS, SECURITY

FACILITY FOCUS

Highlighting NASA Ames' Collapsed Structure Rescue Training Site and how it is helping the emergency-response community

OPPORTUNITY FOR PARTNERSHIP

NASA technology opportunities for private companies

INNOVATIVE RESEARCH

Examples of how NASA is working with small businesses

4

NASA NEWS BRIEFS

Latest happenings from NASA's technology transfer and industry-related areas

16

A LESSON IN...

SBIR/STTR: Guidelines for doing business with NASA

17

LOOKING BACK

Detecting breast cancer with a NASA technology

20

SPECIAL: STRIVING TO PROTECT AMERICA

Imaging technologies aid homeland security

22

INNOVATIVE RESEARCH: ADVANCED CERAMICS RESEARCH GETS HELP

30

32

PAGE 32



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UPFRONT with...

Rear Adm. Craig E. Steidle

ASSOCIATE ADMINISTRATOR, EXPLORATION SYSTEMS MISSION DIRECTORATE



NASA Explores...Humanity Benefits

Exploration provides the foundation of our knowledge, technology, resources and inspiration. As President Bush stated when he unveiled the new Vision for Space Exploration, "This cause of exploration and discovery is not an option we choose; it is a desire written in the human heart."

We are about to set forth on a journey that will mark the beginning of a sustained human presence in the solar system. The Vision for Space Exploration seeks answers to fundamental questions about our existence, responds to recent discoveries and puts in place revolutionary technologies and capabilities to inspire our nation, the world and the next generation, as only NASA can.

The exploratory voyages of the next few decades have the potential, in this lifetime, to answer age-old questions about how life begins, whether life exists elsewhere and how the inevitable discoveries along the way will help better our lives here on Earth.

As we take our first steps toward sustaining a human presence in the solar system, we can look forward to far-off visions of the past becoming realities of the future. Whole industries, currently unknown, will unveil themselves, offering opportunities to our offspring that will make their future, and their children's future, brighter.

For less than 1 percent of the federal budget, technologies from NASA exploration continue to have significant benefits to our lives here on Earth. NASA technology has impacted cancer detection and treatments used in hospitals throughout the world, the treatment of attention deficit disorder (ADD) and the development of cordless power tools, to name just a few.

Over the next century, the Vision for Space Exploration will set in motion activities to improve our understanding of age-old questions, and inspire new generations to pursue math and science. We'll see new industries and technologies evolve that will benefit all humankind. The technologies developed for exploration will underpin and advance the U.S. economy, help to ensure national security and inspire future generations.

I look forward to sharing this future with all of you.



NASA News Briefs

Aviation Technology Test Site Chosen

A public-private partnership, working to develop tools for a better Small Aircraft Transportation System (SATS), has chosen Danville Regional Airport, Danville, Va., as the location to test technologies that could improve general aviation and make air travel more accessible to more people.

NASA and the National Consortium for Aviation Mobility are planning an operational demonstration at the airport in mid-2005 with aircraft equipped with new technologies developed by NASA's SATS project. The goal of the demonstration is to show how emerging aviation technologies can be integrated into operations in an airport environment. This new capability may someday allow more small aircraft and airports to be used safely and reliably by more passengers. It is the culmination of the five-year SATS research project.

Researchers at NASA's Langley Research Center in Hampton, Va.,

and at SATS laboratories across the country are developing integrated airborne systems, cockpit displays and operating procedures for advanced 4- to 10-passenger aircraft. These technologies could help planes safely fly into underused rural and suburban airports, including many airfields that don't have radar or air traffic control towers. About 93 percent of people in the United States live within 30 minutes of one of these airports.



PHOTO CREDIT: NASA/LARC

SATS research is focusing on four operating capabilities that may permit people and goods to travel faster and farther, anywhere and anytime. These technologies will allow higher volume operations at airports that don't have control towers or terminal radar, pilots to land safely in low-visibility conditions at minimally equipped airports, improved single-pilot performance and SATS aircraft to integrate seamlessly into the complex national airspace.

Many of the cockpit systems that enable the SATS operating capabilities are already being developed by NASA, its industry partners and other companies. SATS researchers are working to demonstrate that complex, sophisticated technology can be brought together as an effective, affordable system for smaller airplanes. ■

For more information, contact Elvia Thompson, Office of Public Affairs, NASA Headquarters, 202/358-1696.

Please mention that you read about it in Technology Innovation.

Kennedy-Developed Scaling Device Benefits Law Enforcement

An innovation developed at NASA's Kennedy Space Center to assess damage to the space shuttle following a hailstorm several years ago will now aid the investigations of law-enforcement officials.

Kennedy's Technology Transfer Office successfully completed the negotiation and signing of a patent license with Armor Holdings Forensics, Jacksonville, Fla., for the manufacture and sale of the Scaling and Measurement Device for

NASA, TECHNOLOGY TRANSFER AND INDUSTRY-RELATED NEWS

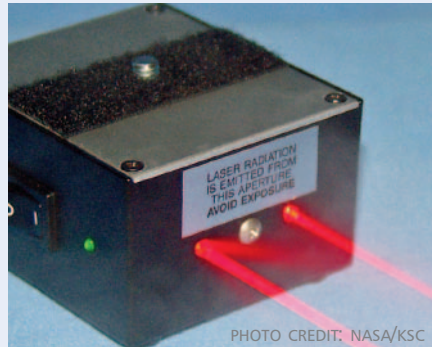
Photographic Images and the accompanying software.

Armor Holdings intends to use the technology in the law enforcement field. Jim Seidel, general manager of forensics at Armor Holdings, says, “We believe crime-scene investigators and traffic-accident investigators will find this device particularly useful in their work.” The device has potential utility wherever remote scaling of a photographic image is required. In addition to investigators, the technology also benefits photographers and surveillance personnel, and has applications in homeland security and the military.

The device uses a laser that projects a known pattern into a camera’s field of view. When a photograph is taken, this pattern appears with the image of the object under investigation, allowing the viewer to quantify the size of the object. Accompanying software calibrates the pattern in the photo image and computes the distance scale for the entire image, saving valuable time in establishing and documenting measurements.

Armor Holdings has provided the forensics industry with tools needed to perform a job efficiently and safely for the past 68 years. Armor Holdings also publishes *Minutiae*, a free bimonthly

newsletter for the benefit of law-enforcement professionals. It contains information on new products, including the scaling device, technical



formulations and historic articles. Information on the scaling device and software is distributed to crime labs around the world. Society benefits from improved investigations and crime prevention as a result of the use of this technology. ■

For more information, contact Allen Miller, Forensic Technical Manager, Armor Holdings Forensics, 13386 International Parkway, Jacksonville, FL 32218, 904/741-1787.

Please mention that you read about it in Technology Innovation.

Magnetic Scanner Improves Business, Security

The ability to read hidden identification codes using a handheld magneto-optic

imager could help businesses improve inventory management, enhance safety, improve security and aid in recall efforts of defective products.

Research at NASA’s Marshall Space Flight Center in Huntsville, Ala., has resulted in a system that will do just that. A team led by Fred Schramm of the MSFC’s Technology Transfer Department, in partnership with PRI, Torrance, Calif., has developed a handheld device that can read special types of coded symbols — even if they are covered by up to six layers of paint. Through a license with NASA, another partner, Robotic Vision Systems Inc. (RVSI), of Nashua, N.H., will sell the imager on the commercial market. NASA continues to seek additional companies to license the product.

Two-dimensional Data Matrix symbols, which incorporate encoded letters and numbers, can be permanently etched on items for identification. The symbols, resembling small checkerboard patterns, are as reliable as traditional bar codes and more efficient, storing up to 100 times more information in the same amount of space.

Before this new technology was available, matrix symbols were read with optical scanners, and only if the codes were visible. But what happens

NASA News Briefs

if the symbols are painted over?
“Once painted, matrix symbols can’t be read by an optical reader,” Schramm says. This creates problems for users such as the Department of Defense and the airline industry, for example, because almost every product eventually gets painted.

“This latest improvement in digital Data Matrix technologies offers greater flexibility for businesses and industries already using the marking system,” Schramm says. Paint, inks and pastes containing magnetic properties are applied in matrix-symbol patterns to objects with two-dimensional codes, and a magnetic imager reads the codes, even after being covered with paint or other coatings. The scanner combines PRI’s magneto-optic imaging technology with RVSI’s Data Matrix decoding techniques into a single handheld unit.

“The ability to read hidden matrix symbols promises a wide range of benefits in a number of fields, including airlines, electronics, healthcare and the automotive industry,” Schramm says. Symbols have been applied to a variety of materials, including metal, plastic, glass, paper, fabric and foam — on everything from electronic parts to pharmaceuticals to livestock.



PHOTO CREDIT: NASA/MSFC

DON ROXBY, ROBOTIC VISION SYSTEMS INC. (LEFT), DEMONSTRATES THE MAGNETIC HANDHELD SCANNER FOR FRED SCHRAMM, MSFC TECHNOLOGY TRANSFER DEPARTMENT.

The portability of the handheld imager makes work faster and easier. It detects codes not only covered by paint, primers, laminates and other coatings but also under conditions that would render optical methods useless. It reads marks in darkness and under bright light that might interfere with optical reading of visible marks, and

it can detect symbols obscured by discoloration or contamination.

“This method is not only for routine marking,” Schramm adds. “There are many industries that would like to hide information on a part, so it can be read only by the party who put it there.” For instance, the automotive

NASA, TECHNOLOGY TRANSFER AND INDUSTRY-RELATED NEWS

industry uses direct parts marking for inventory control and tracking, but for aesthetic purposes the marks often need to be invisible.

The Data Matrix symbol was commercially developed in 1982. MSFC began studying direct parts marking with matrix symbols in 1987 to track the millions of parts used in the space shuttle. Joint efforts by Marshall researchers and industry partners are aimed at improving identification technology as part of NASA's program to better life on Earth through technology designed for the space program.

Schramm notes that the flexibility, permanence and other advantages of marking with matrix symbols give the technology an edge over bar-code labeling for many items. "For instance, where products are too small to accommodate sticky labels, or those to which the labels won't adhere," he says.

Before Data Matrix technology was available, computer chip manufacturers had less effective ways of marking products, and counterfeit and stolen chips flooded the market. The magnetic imaging is the first read-through-paint sensing technology to support industry needs for hidden, machine-readable marks. ■

For more information, contact Fred Schramm, NASA Marshall Space Flight Center, 256/544-0823, Fred.Schramm@nasa.gov.

Please mention that you read about it in Technology Innovation.

NASA Develops Earth-Friendly Fire-Suppression Agent

Fire usually doesn't come to mind when thinking of preserving the ozone layer and preventing global warming. However, at NASA's Kennedy Space Center, those objectives were ever present in the development of a new fire-suppression agent.

KSC has filed a patent application for the dry-powder substance that combines the best properties of water and Halon fire extinguishing agents. The agent is made of microencapsulated water, which means it's not evaporated into the atmosphere, making it a more powerful suppressant that's also appropriate for the environment.

"This offers a replacement for Halons which are currently being used but are no longer manufactured because they are harmful to the environment. This is a new class of fire extinguishing agents that can compete effectively

against other handheld systems," says the technology's visionary, Dr. Clyde Parrish, senior chemist at KSC. Companies interested in further testing and development of the technology could license the technology and manufacture and test the agent. Once successful tests, approvals and studies have been completed, the companies could market the agent as a product, while KSC earns royalties. NASA would then have the option to purchase the commercial product for use.

"Locally, it can be used in firing rooms for electrical equipment and on board the shuttle," Parrish explains. Although the suppressants, in place at numerous KSC locations, are dated, it takes time to research and resolve issues and develop a better option. Knowing the need for a new agent, Parrish envisioned the concept and decided to begin development. After two years, working primarily with three lab associates, he realized the goal of creating the nontoxic fire-suppression agent. "It's always good to see your ideas develop and have some value," Parrish says. "I think this has a lot of interesting potential." ■

For more information, contact Dr. Clyde Parrish, Kennedy Space Center, 321/867-8763.


Please mention that you read about it in Technology Innovation.

cover story Exploration

A detailed image of a Mars rover, likely Curiosity, on a sandy, rocky surface. The rover is equipped with a large solar panel, a mast with various sensors, and six large, treaded wheels. The background is a hazy, greenish-blue, suggesting a distant or futuristic environment. The title 'Life BEYOND' is overlaid on the image, with 'Life' in a dark serif font and 'BEYOND' in a large, white, sans-serif font.

Life BEYOND

A VISION FOR THE FUTURE



At the beginning of the 21st century, our nation stands at a unique time in the history of exploration and discovery. Over the past decade, new evidence of resources on the moon, ancient water on Mars, oceans under the surface of the moons of Jupiter and planets around other stars indicates that our universe is much more habitable than previously thought.

Our generation has the opportunity to answer profound questions asked since ancient times about where we come from, whether life exists elsewhere and how we could live beyond Earth.

D Earth

Answering these questions will require new technologies, capabilities, partnerships and innovations, all of which benefit our lives on Earth. Breakthroughs will be needed in many technical areas, including communications, computation, materials, networking, power, propulsion and robotics. The challenges of space exploration will drive revolutionary capabilities in fields such as nanotechnology, biotechnology and information technology. Partnerships between NASA's human and robotic programs, and with other federal agencies, foreign space agencies and industry and academia will all be key. New ideas, often from unexpected sources, will also play a pivotal role.

In January 2004, President Bush visited NASA Headquarters and announced the Vision for Space Exploration. The vision is a long-term strategy for increasing our knowledge of, and presence in, our solar system and worlds beyond. Instead of setting a single, fixed goal and relying on large budget increases, the vision establishes a series of goals with the schedule flexibility necessary to sustain a long-term program of space exploration.

Shortly after Bush's speech, NASA Administrator Sean O'Keefe created the Exploration Systems Mission Directorate, a new NASA Mission Directorate, at NASA Headquarters. Retired Navy Rear Adm. Craig

Steidle, former manager of the Department of Defense's Joint Strike Fighter Program, leads the office. The office is charged with developing the technologies, systems, vehicles and other capabilities needed to carry out the Vision for Space Exploration. This article describes the major programs and managerial approach of the Exploration Systems Mission Directorate, the potential future benefits of these programs and the office's relationships with other NASA organizations.

Constellation Systems: Enabling Exploration

Named after the patterns that stars form in the night sky, Constellation Systems is responsible for developing the crew exploration vehicle (CEV)

exploration missions to other destinations. The Vision for Space Exploration sets goals of developing, by 2014, a new CEV that is capable of carrying astronauts beyond low Earth orbit, and landing astronauts on the moon no later than 2020.

Constellation Systems employs a spiral approach to requirements definition and system development. Instead of fixing final requirements based on limited knowledge today, Constellation Systems will be developed in stages, during which requirements for the next stage of development are refined using inputs from flight testing and other knowledge gained during the current stage of development and testing. The first boilerplate flight tests of the CEV are scheduled for 2008. They will be followed by more

The challenges of space exploration will drive revolutionary capabilities in fields such as nanotechnology, biotechnology and information technology.

and related exploration architecture systems. Like the Apollo command module, the CEV represents one building block in a future exploration architecture that can send astronauts to the moon and form the basis for

capable, uncrewed flight tests in 2011, leading to the operational, crewed capability in 2014. The Exploration Systems Mission Directorate employs a requirements division that works in concert with

its development division on this iterative process of development, testing and requirements refinement.

As early as 2015 the CEV will be integrated with other exploration

The Exploration Systems Mission Directorate places a high value on finding and leveraging the best ideas, wherever they may be found in our nation.

The Vision for Space Exploration places a high value on sustainable approaches to space exploration and research.

systems in a lunar architecture. Constellation Systems employs a system-of-systems approach to exploration architecture planning and development. It seeks to understand the implications of various systems trades on the total architecture, both for current and future applications. Other architecture elements may include communications platforms, lift capability, transfer stages, assembly capability, landers, habitation, life support, surface mobility and science instruments. Ultimately, this lunar architecture will serve as the first spiral in the development of future exploration architectures that can enable more expansive lunar operations, deploy and service very large space observatories and mount research expeditions to Mars.

More than 1,000 inputs from NASA centers, industry, academia and other interested organizations and individuals have been received in response to a Constellation Systems request for information. These inputs will help form the basis for a broad agency announcement on Constellation Systems concept refinement that will be released in the summer of 2004. A request for proposal on Constellation Systems' technology development is planned for release next year. Subsequent downselects will lead to a CEV fly-off in 2008. The final downselect for the CEV will consider the technical merits of the CEV proposals and flight tests, technology development and risk reduction for Constellation Systems' first lunar architecture, and concept work on future exploration architectures.

Technology Research and Development

The Vision for Space Exploration places a high value on sustainable approaches to space exploration and research. Unlike major human space exploration efforts of the past, the vision seeks to establish a long-term series of robotic and human exploratory activities that gradually grow in both distance and capability without requiring large spikes in resources and funding. The major components within the technology research and development area are human and robotic technology and Prometheus.

Human and Robotic Technology: Transforming Exploration

Human and robotic technology (HRT) is responsible for identifying and maturing the technologies that can transform future space systems and exploration architectures and make them more sustainable. HRT technologies, subsystems and demonstrations form the basis for developing future vehicles and systems in Constellation Systems architectures, including the CEV.

HRT consolidates and aligns previous NASA technology program areas, including mission and science measurement and innovative technology transfer, and augments them with a dedicated technology maturation

program to ensure that promising technologies make their way into operational flight system development. Examples of high-priority investment areas, from an initial mapping of technology program areas to exploration, need to include integrated vehicle health management, in-flight refueling and in-space assembly. These and other HRT investments will be made to improve system reusability, reliability and effectiveness, all of which contribute to the strategy of sustainable exploration. Investments now in such technologies will help

to ensure their availability when they are needed for future spirals and more-complex operations.

HRT seeks innovation widely and employs competitive approaches to find the best ideas. The Office of Exploration Systems will solicit responses to intramural and extramural calls for proposals, which will be awarded later this year. A follow-up award, to be presented next year, will address specific technology gaps for the CEV. Centennial Challenges, a program of prize competitions that augments HRT and other NASA programs, will reward specific

accomplishments that advance solar system exploration and tap ingenuity wherever it may be found in our nation.

Project Prometheus: Powering Exploration

The nation's Vision for Space Exploration lays out a multi-decade road map for gradually more capable and expansive space activities, including long-term stays on the lunar surface to test exploration systems and leverage lunar resources, more-extensive robotic missions to search for life on Jupiter's moons and

PRESIDENT GEORGE W. BUSH DELIVERS REMARKS ON U.S. SPACE POLICY AT NASA HEADQUARTERS IN WASHINGTON, D.C., WEDNESDAY, JAN. 14, 2004.

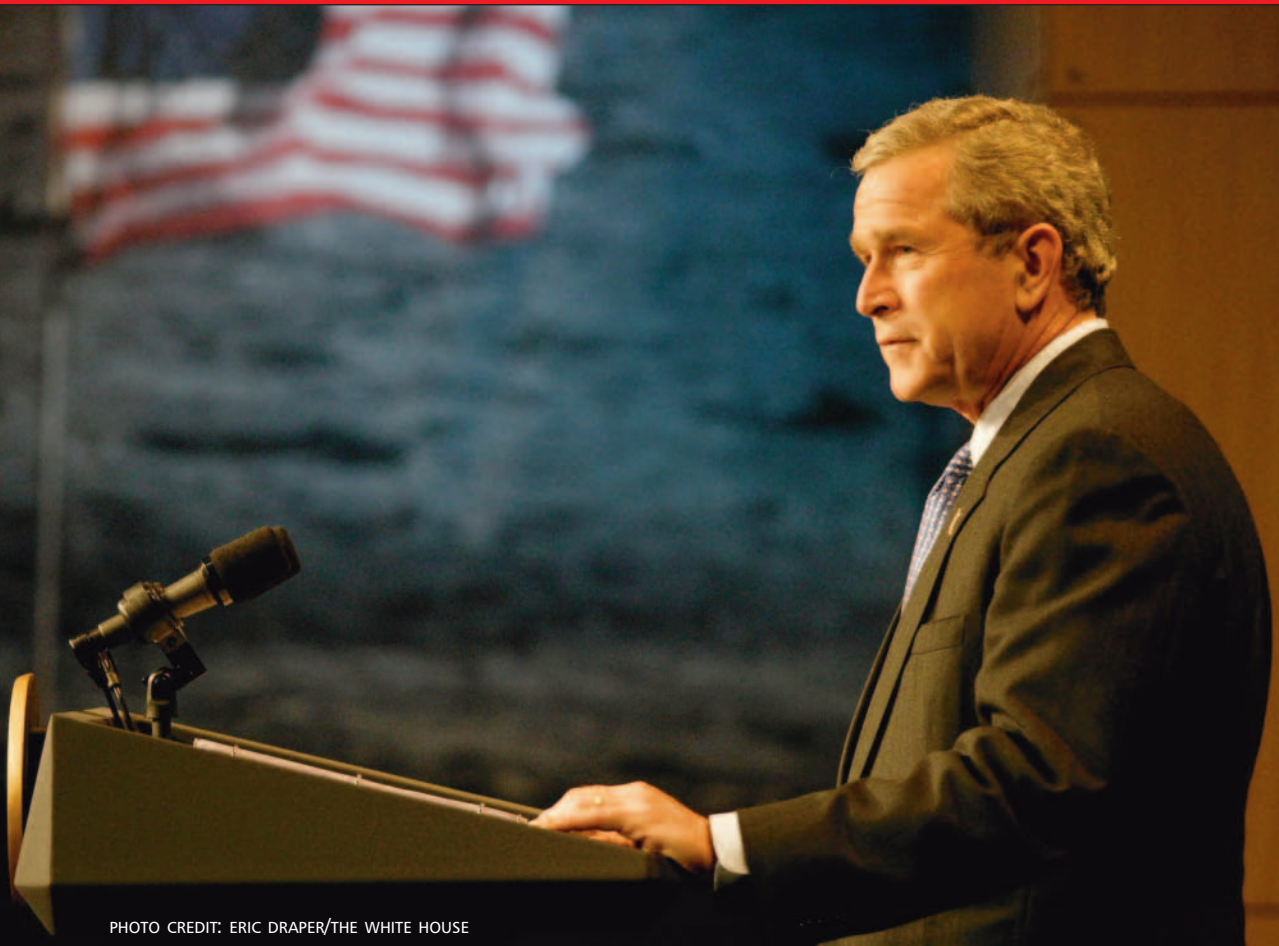


PHOTO CREDIT: ERIC DRAPER/THE WHITE HOUSE

explore the outer solar system, and astronaut expeditions to Mars to understand that planet's potential for life. High-energy, deep-space power — fueled by nuclear-fission technology — is critical to successfully complete these activities. Project Prometheus, named after the mythological Greek titan who gave humanity the gift of fire, is responsible for developing the nuclear-fission power and propulsion systems necessary to enable these applications.

The first major application of Prometheus technology is on the Jupiter Icy Moons Orbiter (JIMO) mission, scheduled for launch around the middle of the next decade. NASA's Office of Space Science is responsible for JIMO science instruments and research, while NASA's Exploration Systems Mission Directorate provides the underlying power, propulsion and spacecraft systems necessary to support these instruments.

Following up on tantalizing evidence uncovered by the Galileo mission of oceans deep under the icy surfaces of three of Jupiter's moons — Europa, Callisto and Ganymede — JIMO will be unlike any previous planetary science mission. Rich in power and propulsive capability, JIMO can orbit each moon for up to a year, probing subterranean oceans with new, powerful instruments and potentially placing small landers on the surface of one or more of these worlds. At the end of JIMO's tour, scientists will have complete maps of three new

Did You Know?

An interesting fact to stimulate the mind

Who named the famous mission to the moon, "Apollo"?

Dr. Abe Silverstein. In early 1960, Silverstein named the manned journey to the moon "Apollo" after one of the most versatile of the Greek gods. The name was chosen after Silverstein was perusing a book of mythology. He thought the image of Apollo riding his chariot across the sun was appropriate to the grand scale of the proposed program.

oceans on three worlds, each a potential abode of life, and the geophysical and chemical information to know how best to search for life on these moons.

applicable to other robotic missions to our outer solar system, such as spacecraft to Saturn's moon Titan, Neptune's moon Triton and the Kuiper Belt. Depending on what systems and resources are ultimately tested and mined at the Earth's

Project Prometheus... is responsible for developing the nuclear-fission power and propulsion systems...

The investment required to develop any nuclear system is substantial, and the Exploration Systems Mission Directorate is seeking ways to best align and leverage investment in the JIMO nuclear power source toward follow-on applications. JIMO power and propulsion systems will be

moon, JIMO's power system may be adapted with relatively few modifications to serve as a lunar-surface power source. With certain modifications to accommodate the Martian atmosphere, JIMO's power source may play a similar role on the

PHOTO CREDIT: NASA/JSC

Office of Naval Reactors will provide key inputs on Prometheus design and operations.

Planetary and Astrophysical Research: Partnering Exploration and Discovery

Products from the Exploration Systems Mission Directorate provide key enabling and enhancing capabilities for Office of Space Science research. One example is nuclear-fission power, a capability provided by the Exploration Systems Mission Directorate to enable JIMO, a mission of the Office of Space Science. Another example is in-space assembly, an Exploration Systems Mission Directorate capability that will likely prove critical to the deployment and maintenance of

worlds around other stars for evidence of life. In the near term, the Office of Space Science and the Exploration Systems Mission Directorate are working together to understand common areas of interest in space rendezvous and robotic servicing that could lengthen the operational life of the Hubble Space Telescope and benefit future exploration architectures.

In other programs, Office of Space Science missions will support the Exploration Systems Mission Directorate by providing important planetary data and technology demonstrations. The Lunar Exploration Program consists of a series of robotic missions managed by the Office of Space Science to serve as precursors to future human exploration missions. The first of these missions, a 2008 lunar orbiter, will help confirm or disprove the existence of specific lunar resources, which may have profound implications for how the first Constellation

surface of Mars for both robotic and human systems. Eventually, larger-scale nuclear power and propulsion systems will likely provide the means by which human expeditions are safely sent beyond the Earth-moon system to the asteroids, Mars and other destinations.

The Exploration Systems Mission Directorate recently released a request for proposal (RFP) for the JIMO mission. To help ensure that the JIMO power source is useful beyond the JIMO mission itself, the JIMO RFP specifies other robotic and human mission applications. With the development of any nuclear system, safety is paramount. NASA will work with the Department of Energy's Office of Naval Reactors to assist with Prometheus development. With a perfect safety record, the

Products from the Exploration Systems Mission Directorate provide key enabling and enhancing capabilities for Office of Space Science research.

future, large-space observatories. These observatories will allow scientists to understand the worlds of our solar system in the context of other solar systems and to search

Systems architecture develops. Similarly, a new line of robotic missions in the Mars Exploration Program will provide critical information about Mars hazards

and resources, and demonstrate technologies that will provide key inputs into Exploration Systems Mission Directorate architecture trades, requirements development and systems investments. The first launch of these robotic missions to Mars is planned for 2011.

...but the great discoveries and practical benefits to come will be very rewarding.

microgravity countermeasures, is key to the design of future exploration

The international space station and space shuttle are on the critical path to conducting this research and developing

these human-support systems.

Historically, research in these areas yields substantial benefits for medical and other applications on Earth. Spin-off technologies have included improved cancer-detection instruments, new cancer treatments, new cardiovascular implants, improved breathing apparatuses, cordless power tools, fire-detection sensors and improved water purification.

Audentes Fortuna Juvat — Fortune Favors the Bold

The Vision for Space Exploration lays out a bold yet responsible plan for exploring our solar system, its potential for life and worlds beyond. By aligning investments, defining programmatic approaches, establishing procurement strategies and partnering with other NASA organizations, NASA's Exploration Systems Mission Directorate has taken the first steps to fulfilling the vision. Much work lies ahead, but the great discoveries and practical benefits to come will be very rewarding. ■

AN ARTIST'S RENDITION OF NASA'S SPIRIT ROVER



PHOTO CREDIT: NASA/JPL

Bioastronautical Research: Discovery Supporting Exploration

Research on the effects of the space environment on the human body, along with the development of appropriate radiation and

vehicles and architectures. Similarly, life-support systems, remote medical systems and other technologies necessary to support human crews with a minimum of supplies and intervention from Earth, are also important to enabling sustainable exploration.

For more information regarding the Vision for Space Exploration, please visit www.nasa.gov or contact the Exploration Systems Mission Directorate.

Please mention that you read about it in Technology Innovation.

A Lesson In...

GUIDELINES FOR DOING BUSINESS WITH NASA

SBIR/STTR

Congress established the Small Business Innovation Research (SBIR) program in 1982 to provide increased opportunities for small businesses to participate in R&D, increase employment and improve U.S. competitiveness.

The program's specific objectives are to stimulate U.S. technological innovation, use small businesses to meet federal research-and-development (R&D) needs, increase private-sector commercialization of innovations derived from federal R&D, and foster and encourage participation by socially disadvantaged businesses. Legislation enacted in 2000 extended and strengthened the SBIR program

and increased its emphasis on pursuing commercial applications of SBIR project results.

The Small Business Technology Transfer (STTR) program awards contracts to small-business concerns (SBC) for cooperative research and development with a nonprofit research institution, such as a university. The goal of Congress in establishing the STTR program is to facilitate the transfer of technology developed by a research institution through the entrepreneurship of a small business. The small business and its partnering institution are required to sign an agreement detailing how they will share intellectual property. Modeled after the SBIR program, with the same basic requirements and phased funding structure, the STTR program is nevertheless a separate activity and is separately funded.

The STTR program is smaller than the SBIR program. The funding set-aside is 0.3 percent of the extramural R&D budget, approximately one-twentieth of the amount for SBIR. The small company must take the research and intellectual property of the research institution and convert it into a useful product. In comparison to the SBIR program, twice as much time is allowed for Phase I, and Phase II lasts two years. Also, although the proposal is still submitted by the SBC, at least 30 percent of the funding and work must originate with the research institution, while only a minimum of 40 percent must come from the SBC. Phase I STTR projects receive up to \$100,000 for a one-year effort. The maximum contract value for STTR Phase II is increasing from \$500,000 to \$600,000 as of the 2003 solicitation.

The STTR program solicitation research areas correspond to the central underlying technological competencies of each participating NASA Center. The Jet Propulsion Laboratory (JPL) does not participate in the management of the STTR program. ■

For more information, please visit the SBIR/STTR Web site at <http://sbir.gsfc.nasa.gov/SBIR/SBIR.html>.

Looking Back

A FOLLOW-UP ON A NASA SUCCESS



PHOTO CREDIT: NASA/JPL

Breast Cancer Detection

Infrared sensors used in NASA space missions have found a place in the early detection of breast cancer.

minute differences accompanying the blood-flow changes associated with cancerous cells. The QWIP was designed for planetary exploration and terrestrial surveillance.

OmniCorder has developed two types of scanning designs. One is a bed designed for breast cancer examination. The patient lies facedown and places her breast in a hole in the table. The camera is positioned under the table and does not come into direct contact with the breast. The other setup is similar, but it requires the patient to stand on a platform.

In December 1999 OmniCorder received 510K clearance from the Food and Drug Administration to market the BioScan system. The company has conducted clinical trials of the system at Stony Brook University Hospital, the Mayo Clinic and Harvard Medical School's Dana-Farber Cancer Institute. ■

For more information, contact Debora Avila, debora.l.avila@jpl.nasa.gov.

Please mention that you read about it in Technology Innovation.

In 2001 the National Cancer Institute reported that cancer incident rates had decreased about 0.5 percent a year since 1991. One of the factors cited in the decline was early detection. Through technology developed at NASA, OmniCorder Technologies in Stony Brook, N.Y., is trying to continue this trend.

Today, infrared sensors used in space are aiding in the early detection of breast cancer. Through an exclusive license agreement signed in 1997 with NASA's Jet Propulsion Laboratory, OmniCorder created the BioScanIR System, which is able to locate cancerous lesions by detecting the cancer's ability to recruit a new blood supply. Blood-flow differences are known to occur in the earliest stages of cancer development. The technology uses JPL's quantum well infrared photo detection (QWIP). A digital sensor detects infrared energy emitted from the body and identifies the

feature

Imaging Technology

Video-Enhancing System

puts criminals



PHOTO CREDIT: EMMETT GIVEN AND DR. DAVID HATHAWAY, NASA/MSFC

From bombings and other homeland security threats, to child abductions, to verifying the “real” Saddam Hussein, a video-enhancing system developed at NASA’s Marshall Space Flight Center is proving to be a valuable law-enforcement tool. It’s helping agencies investigate crimes and put criminals behind bars.

NASA INVENTORS PAUL MEYER (LEFT) AND DR. DAVID HATHAWAY VIEW A LICENSE PLATE NUMBER REVEALED BY USING VISAR.

It’s been an unlikely outcome for an invention that started out as an effort by two space scientists to come up with a tool to assist in their studies of the sun and weather systems on Earth.

The technology known as VISAR — short for video image stabilization and registration — can turn dark, jittery images captured by home video, security systems and video cameras mounted in police cars into clearer, stable pictures.

NASA scientists Dr. David Hathaway and Paul Meyer, who study violent explosions on the sun and examine hazardous weather conditions on Earth,

created VISAR to aid in their space-program research. Now, through NASA’s commercial licensing process, the technology has become available in the marketplace and is increasingly finding applications with down-to-earth benefits.

VISAR has been licensed commercially by Intergraph Corp. of Huntsville, Ala., and incorporated into Video Analyst, a workstation that can stabilize and enhance video, brighten dark pictures and enlarge small sections of pictures to reveal clues about crimes. The system is built around the industry-standard Microsoft Windows operating system and Adobe Premiere

video-editing software.

“VISAR has a proven track record in delivering solid video evidence and is of paramount importance in our success with Video Analyst,” says Trey McKay, manager of Intergraph’s Integrated Products Division, Intergraph Solutions Group.

The VISAR “track record” includes about a dozen criminal cases in which Hathaway and Meyer have assisted police departments and the FBI. The first, and still most notable, in the string of investigations was analysis of video from the bombing in Atlanta’s Centennial Park during the 1996 Summer Olympics. In

that case, Hathaway and Meyer worked with the bureau to enhance poor-quality video clips.

More recently, ABC News asked Intergraph's Gene Grindstaff to analyze video clips that aired on Iraqi television, apparently showing Saddam Hussein. Officials wanted to verify whether Hussein survived a U.S. air strike the previous day, or whether the video was of a body double. Using Video Analyst with VISAR, Grindstaff took about 90 minutes to compare the ABC footage to prior Iraqi TV images of Hussein and determined — with 99 percent certainty — that it was Hussein.

Hathaway, Meyer and Sammy Nabors of the technology transfer department — won the Federal Laboratory Consortium's Excellence in Technology Transfer Award for VISAR. Nabors works with Marshall scientists interested in patenting their inventions, and his department encourages companies to license products for commercial applications.

VISAR was named NASA's Commercial Invention of the Year in 2003. Hathaway and Meyer were also nominated by NASA to compete for the national Inventor of the Year Award, and they were among the five finalists in the competition, which

...took about 90 minutes to
compare the ABC footage to prior Iraqi TV
images of Hussein and determined — with
99 percent certainty — that it was Hussein...

Demonstrated capabilities such as these apparently are convincing for customers. A Chicago-area law-enforcement association, the South Suburban Mayors and Managers Association, purchased Video Analyst based specifically on its inclusion of the NASA-developed VISAR, McKay says. The association pooled resources to buy Video Analyst and 15 portable units, making the system available to 43 municipalities in the Illinois counties of Cook — which includes Chicago — and Will.

Three Marshall employees —

recognizes outstanding American inventors whose work has been patented or made commercially available. ■

For more information, contact Sammy Nabors, Marshall Space Flight Center, 256/544-5226.

Please mention that you read about it in Technology Innovation.

Imaging Technologies Strive to Protect America

Aiding Homeland Security

The environment in this country presents an almost infinite number of potential targets for terrorists, and our Department of Homeland Security (DHS) has the intimidating task of protecting these targets.

The need for clear analysis of data for evaluating, strategizing and planning has never been more crucial. Engineers at NASA's Kennedy Space Center (KSC) have developed a series of imaging-processing technologies that have potential applications in areas such as pattern recognition, remote sensing, monitoring, biometrics, optical character recognition and handwriting analysis.

Software providing an improved means of pattern recognition was developed at KSC. Pattern-recognition software is valuable in homeland security, as it allows one to comb through enormous sets of data looking for links and patterns, to investigate what may have already occurred, and, more importantly, to predict what may be planned to occur. KSC's software is a tractable and empirically accurate algorithm, along with an integrated framework, that results in a visual process for pose invariant pattern recognition (PIPR). The algorithm and overall framework take advantage of hypotheses provided by a high-level visual process, thereby attempting to extract a region in an image based on these hypotheses. NASA's PIPR technology operates independently of rotation or scale of the object. PIPR also requires no advance knowledge of the characteristics of images to be analyzed and provides an explicit indicator-of-match.

PIPR uses two reference points and two image points instead of one. The selection of two boundary points whose gradient angles are parallel determines a unique parallel gradient identifier angle. This parallel angle is the basis for PIPR's

rotational and scalar invariance. As a result, PIPR can simplify the computational process by testing only a single hypothesis rather than testing multiple hypotheses through the range of possible rotations and scales. Additional algorithms incorporated into PIPR quantify the level of match, which allows PIPR to identify objects even when there is not an exact match.

The DHS's image analysts can use the PIPR software to locate a predefined or known shape in images, such as a missile or rocket in aerial images of a terrorist's training camp.

Several other KSC software-imaging

technologies that may have applications in homeland security are based on "fuzzy reasoning." Fuzzy reasoning is an approach to computing based on "degrees of truth" rather than the usual "true or false" logic on which the modern computer is based. Fuzzy reasoning seems closer to the way a brain works and is used in making machines do

a better, more precise job. For example, the thermostat in an oven controls the temperature by turning the oven on when it gets below the set temperature and off when it gets above the set temperature. A thermostat using fuzzy reasoning would be able to have the oven running all the time, partially on, making the oven stay at the desired temperature and run more efficiently.

The first technology relies on edge detection via fuzzy reasoning and has tremendous applications in pattern recognition and surveillance. In imaging, edges carry the most important information, and accurate edge detection is vital to performing advanced image processing and analysis. NASA's fuzzy reasoning edge

detection (FRED) system uses heuristics that mimic the capability of humans to approximate solutions, making it ideal for detecting edges in noisy, cluttered environments and unfamiliar objects.

Because it requires no advance knowledge of image characteristics, FRED has significant advantages over standard techniques. This fuzzy-reasoning approach to detecting image edges significantly supersedes current and widely used edge-detection methods such as Sobel and Prewit. An image of a CD was taken as a sample to compare methods; the fuzzy-reasoning approach shows tiny edge

details not detected by the other methods. FRED uses a 3-by-3 window to scan the whole image and perform a heuristic analysis to find an optimal intensity gradient based on a 3-by-3 center pixel. FRED then generates a crisp center pixel value based on evaluation of a fuzzy membership function with

respect to the optimal intensity gradient.

NASA currently uses FRED in two critical systems: The first system is used to identify and track foreign object debris (FOD) during space shuttle liftoff and is a key component of the current analysis in the investigation of the space shuttle Columbia explosion. The second system, the Cable and Line Inspection System (CLIM), is used to test the space shuttle's emergency escape system. In homeland security this technology can be used for anomaly or defect detection, surveillance, visual-motion control, face recognition, object tracking, handwriting recognition and robotic vision.

The next technology based on fuzzy reasoning is a new fast-computational

technique developed to find an optimal binary image threshold. NASA's fuzzy reasoning adaptive thresholding (FRAT) system is ideal for binarizing noisy, cluttered or textured gray-scale images. FRAT is faster and more reliable than other current, highly dependable methods. FRAT can transform a poorly faded signature, a weathered document or surveillance tape of a license plate into a clearer, readable image.

FRAT defines an image as an array of fuzzy singletons corresponding to image pixels. With two classes, background and foreground, the membership function is built based on the average gray level of each class, which is computed using the gray level histogram as average weight factor.

By using an unrestricted range and a straightforward triangular-type membership function, FRAT takes advantage of a simple linear function as the basis for its entropy measure. The entropy measure is then used as a cost function for the selection of the optimal image threshold.

Security efforts have increased drastically since the terrorists attacked the United States, and they will continue to intensify. The strategic objectives of homeland security are to prevent attacks, reduce America's vulnerability, and minimize damage and recover from current and future attacks. Although improved imaging technologies are important to NASA's operations, they also can have a great impact on achieving the objectives of this homeland security strategy. The three imaging technologies described are available for licensing and further development by industry. ■

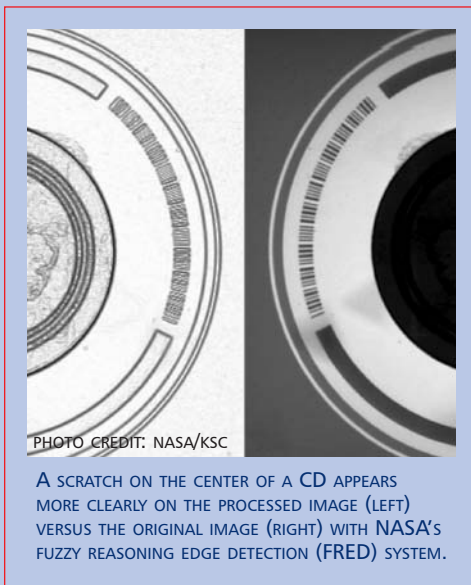


PHOTO CREDIT: NASA/KSC

A SCRATCH ON THE CENTER OF A CD APPEARS MORE CLEARLY ON THE PROCESSED IMAGE (LEFT) VERSUS THE ORIGINAL IMAGE (RIGHT) WITH NASA'S FUZZY REASONING EDGE DETECTION (FRED) SYSTEM.

For more information, contact Jeffrey A. Kohler, Kennedy Space Center, 321/861-7158, jeffrey.kohler-1@ksc.nasa.gov.

Please mention that you read about it in Technology Innovation.

Facility Focus

**HIGHLIGHTING A NASA FACILITY
THAT PROVIDES FUNCTION BEYOND
SPACE EXPLORATION**

The Collapsed Structure Rescue Training Site

NASA's Ames Research Center not only focuses on innovative technologies for use in space, but it also has concerns on land.

Through its Collapsed Structure Rescue Training Site, Ames is providing the emergency-response community with a beneficial and elaborate training facility.

The Collapsed Structure Rescue Training Site falls under the auspices of the Disaster Assistance and Rescue Team (DART), an all-hazard federal emergency response and recovery team based at Ames' Moffett Field, Calif., facility.

The collapsed structure is one of many components of DART. The structure itself has four major parts: a large concrete rubble pile with built-in voids and rooms, a simulated concrete collapsed structure, a 30-foot-long twin-engine aircraft "crashed" into a portion of the structure and large concrete loads for lifting and moving. One of the structure's uses is an annual advanced rescue class sponsored by DART that attracts participants from around the country.

Emergency-response groups using the facility can



position the structure in a number of ways to set up various training scenarios.

The structure includes both above-grade and basement rooms, which can be used to simulate different hazards. It can be set up for scenarios over a 24-hour period or for search-and-rescue teams to train in a collapsed-structure environment. The structure also includes a rubble pile that provides emergency responders with the opportunity to train with breaching equipment in an unstable, offset environment. The rubble pile can also be used for search training and practice with stabilizing loads in a dynamic environment.

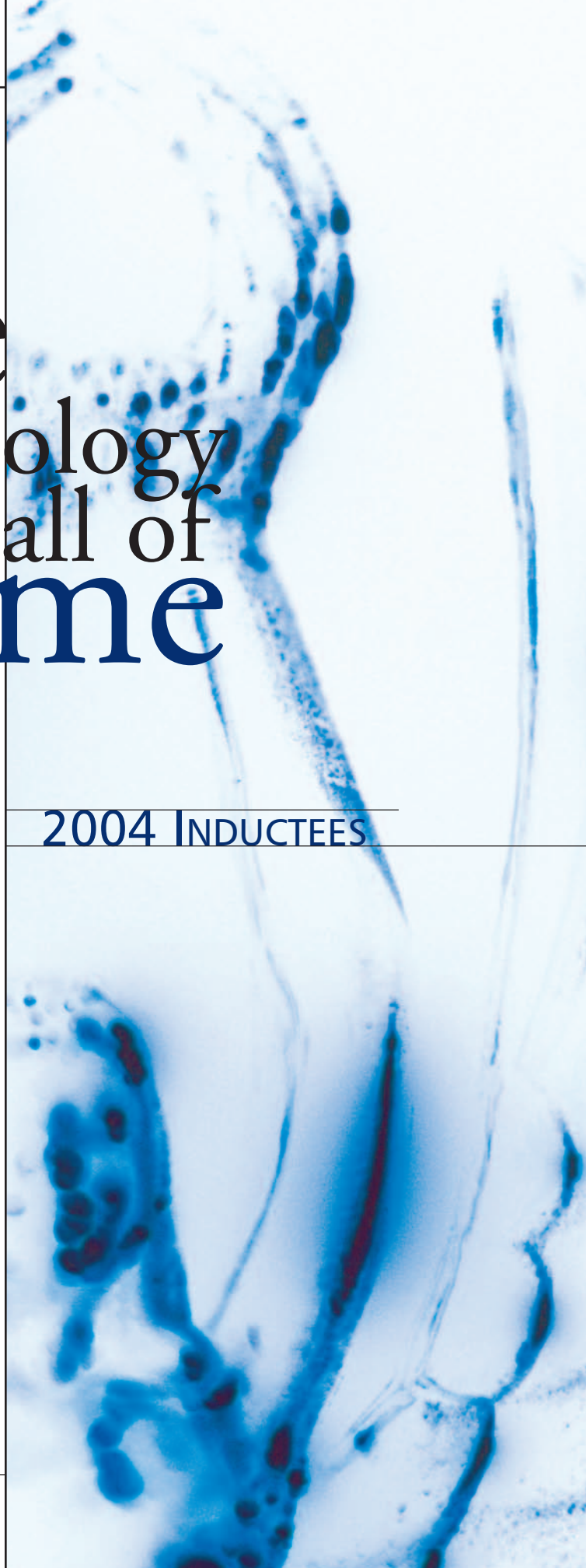
The facility is used by members of DART and is open to all members of the emergency-response community. ■

For more information, please visit the DART Web site at <http://dart.arc.nasa.gov>.

Space Technology Hall of Fame

“**F**or 16 years, the Space Foundation has honored extraordinary space technologies that enhance the quality of life on Earth through its Space Technology Hall of Fame program,” says NASA Administrator Sean O’Keefe. “The 2004 Hall of Fame honorees are a shining example of how the exploration of space returns incredible and sometimes unexpected benefits for all of us on Earth.”

2004 INDUCTEES



The Space Foundation announced the selection of four “down to earth” technologies for induction into the Space Technology Hall of Fame. Three were spawned by NASA efforts, and the fourth by the work of the U.S. Air Force Research Laboratory.

The 2004 Hall of Fame inductees range from a medical technology that enables thousands of people to see better, to software with the ability to determine the location of satellite orbits with pinpoint accuracy.

The four products incorporating space-based technologies being inducted this year are LADARVision 4000 (LASIK eye surgery), the MedStar Medical/Health Monitoring System, Precision GPS (global positioning system) Software System and Multi-Junction (MJ) Space Solar Cells. Each brings to Earth a different life-enhancing benefit from space technology.

Space Foundation President and Chief Executive Officer Elliot G. Pulham says, “Our 2004 honorees represent space technologies that save lives, enable thousands of people to see better, power modern global telecommunications and make travel safer for millions. They are great examples of why what we do in space matters on Earth.”

The inducted technologies and innovators were honored at the 16th



PHOTO CREDIT:
SPACE TECHNOLOGY
HALL OF FAME

Space Technology Hall of Fame dinner, held at the Broadmoor Hotel in Colorado Springs, Colo. The awards dinner, cosponsored by

The Space Foundation, in cooperation with NASA, established the Space Technology Hall of Fame in 1988 to honor the innovators who have transformed space technology into commercial products, to increase public awareness of the benefits of space technology and to encourage further innovation.

Following are capsules of the four inductees in the Space Technology Hall of Fame for 2004.

LADARVision 4000

Fewer and fewer people now need eyeglasses or contact lenses, thanks to laser vision-correction surgery. Laser-Assisted In Situ Keratomileusis, or LASIK, is the most widely performed surgical procedure. It uses a laser and eye-tracking device to reshape the cornea and is

“...honorees represent space technologies that save lives, enable thousands of people to see better, power modern global telecommunications and make travel safer for millions.”

Boeing Co., was the capstone of the 20th National Space Symposium. Jim Albaugh, president and chief executive officer, Boeing Integrated Defense Systems, was the evening's corporate host.

based on technology used to assist spacecraft in delicate docking maneuvers. This enables LASIK to provide unmatched precision.

MedStar Monitoring System

The cost of caring for the chronically ill continues to grow. In-home care is part of the solution, and statistics show significant patient health improvements through closer in-home monitoring. Cybernet's MedStar system, which evolved from research funded by NASA, the National Institute of Mental Health and the Advanced Research Projects Agency, allows healthcare professionals to remotely monitor their patients. This miniature physiological monitoring device, which also is used to monitor astronauts on the international space station, can collect and analyze a multitude of signals in real time.

Precision Global Positioning System (GPS) Software System

In 1985 NASA's Jet Propulsion Laboratory (JPL) began developing software to determine the location of satellite orbits with pinpoint accuracy. This work led to the development of a sophisticated system that incorporates special GPS algorithms and now uses the Internet to deliver information enabling real-time positioning accurate to within a few inches anywhere in the world for terrestrial users and for space-borne users in low-Earth orbit. The Federal Aviation Administration has adopted JPL's software in its GPS-based navigation system to improve safety for millions of air travelers.

Multi-Junction (MJ) Space Solar Cells

Responding to the need for higher-efficiency solar cells, the U.S. Air Force Research Laboratory sponsored research-and-development efforts to produce high-efficiency multi-junction (MJ) space solar cells. MJ solar-cell technology provides a direct replacement for lower-efficiency single-junction cells. The results are reduced costs for the life cycle of space missions, telecommunication, weather forecasting and many other services crucial to our daily lives on Earth. ■

For more information, contact Michael Braukus, Office of Public Affairs, NASA Headquarters, 202/358-1979.

Please mention that you read about it in *Technology Innovation*.

JIM ALBAUGH, PRESIDENT AND CHIEF EXECUTIVE OFFICER, BOEING INTEGRATED DEFENSE SYSTEMS, HOSTS THE AWARDS DINNER.



PHOTO CREDIT: SPACE TECHNOLOGY HALL OF FAME



LED Enhance

SKIN, BONE AND MUSCLE CELLS GROWN IN CULTURES ARE EXPOSED TO THE SAME LIGHT-EMITTING DIODES USED TO TREAT WOUNDS IN PATIENTS AND GROW PLANTS IN SPACE.

A nurse holds a strange-looking device, moving it slowly toward a young patient's face. The notecard-size device is covered with glowing red lights, but as it gets closer, the youngster shows no fear. He's hopeful this painless procedure using an array of lights will help ease or prevent some of the pain and discomfort associated with cancer treatment.



Quality of Life

PHOTO CREDIT: NASA/MSFC AND BARRY HIMELHOCH, MEDICAL CENTER GRAPHICS INC.

The youngster is participating in the second phase of human clinical trials for this healing device. The first round of tests, conducted by Medical College of Wisconsin researchers at Children's Hospital of Wisconsin in Milwaukee, was so encouraging that doctors have expanded the trials to several U.S. and foreign hospitals.

"We've already seen how using LEDs can improve a bone-marrow transplant patient's quality of life," says Dr. Harry Whelan, professor of neurology, pediatrics and hyperbaric medicine at the Medical College of Wisconsin. "These trials

will hopefully help us take the next steps to provide this as a standard of care for this ailment."

The light is produced by light-emitting diodes, or LEDs. They are used in hundreds of applications, from electronic-clock displays to jumbo TV screens.

LEDs provide light for plants grown on the international space station, where plants are needed for food and air revitalization during human trips to Mars. Researchers discovered the diodes also had many promising medical applications, prompting NASA to fund this

research as well, through Marshall Space Flight Center in Huntsville, Ala.

Biologists have found that cells exposed to near-infrared light from LEDs, which is energy just outside the visible range, grow 150 percent to 200 percent faster than cells not stimulated by such light. The light arrays increase energy inside cells that speed up the healing process.

In the first phase of the study, use of the LEDs resulted in significant relief to pediatric bone-marrow transplant patients suffering the ravages of oral mucositis, a common side effect of chemotherapy and

radiation treatments, according to Dr. David Margolis, an associate professor of pediatrics at the medical college, working with Dr. Whelan on the study at Children's Hospital.

Many times, young bone-marrow transplant recipients contract this condition, which produces ulcerations in the mouth and throat, severe pain, and, in some cases, inflammation of the entire gastrointestinal tract. Chewing and swallowing become difficult, if not impossible, and a child's overall health is affected because of reduced drinking and eating.

"Our first study was very encouraging, and using the LED device greatly reduced or prevented the mucositis problem, which is so painful and devastating to these children," says Whelan. "But we still need to learn more. We're conducting further clinical trials with larger groups and expanded control groups, as required by the U.S. Food and Drug Administration, before the device can be approved and available for widespread use."



A NURSE PRACTITIONER PLACES THE WOUND-HEALING, LED ARRAY ON THE OUTSIDE OF A PATIENT'S CHEEK. THE LIGHT EMITTED BY LEDs HAS BEEN USED TO HELP PLANTS GROW ON NASA'S SPACE SHUTTLE.

outside of a patient's left cheek for just over a minute each day. The process was repeated over the patient's right cheek, but with foil placed between the LED

throat area, which provided the control for the first study.

The researchers compared the percentage of patients with ulcerative oral mucositis to historical epidemiological controls. Just 53 percent of the treated patients in the bone-marrow transplant group developed oral mucositis, considerably less than the usual rate of 70 percent to 90 percent. Patients also reported pain reduction in their mouths, compared to untreated pain seven days following bone-marrow transplant.

The clinical trials are expected to take approximately three years and include 80 patients. Participants currently include the Medical College of Wisconsin in Milwaukee, Wis.;

...cells exposed to near-infrared light from LEDs...grow 150 percent to 200 percent faster than cells not stimulated by such light. The light arrays increase energy inside cells that speed up the healing process.

The treatment device was a 3-by-5-inch portable, flat array of light-emitting diodes. It was held on the

array and the patient, to provide a sham treatment for comparison. There was no treatment of the

PHOTO CREDIT: NASA/MSFC AND BARRY HIMELHOCH,
MEDICAL CENTER GRAPHICS INC.

Roswell Park Cancer Institute in Buffalo, N.Y.; and Instituto de Oncologia Pediatrica, in Sao Paulo, Brazil. Other domestic and international hospitals have asked to join the multicenter study.

Quantum Devices of Barneveld, Wis., makes the wound-healing LED device. The company specializes in the manufacture of silicon photodiodes, or semiconductor devices, used for light detection; and light-emitting diodes, for commercial, industrial and medical applications. ■

For more information, contact Dolores Beasley, Office of Public Affairs, NASA Headquarters, 202/358-1753.

Please mention that you read about it in Technology Innovation.

Did you know?

An interesting fact to stimulate the mind

What led to the creation of today's insulin pump?

The Mars Viking space probe. NASA's research to miniaturize satellite components and technology based on a design used in the biological lab of the Mars Viking space probe made the creation of a small, implantable insulin pump reality. NASA's work on communication was the key to how the device is programmed. In November 1986 the first programmable implantable medication system was implanted in a patient at Johns Hopkins Hospital.

Opportunity for Partnership

Micro-Pulse Lidar

Lidar is much like radar, but it operates with light wavelengths rather than radio waves.

Developed at NASA Goddard Space Flight Center, this innovative micro-pulse lidar (MPL) system provides autonomous monitoring of atmospheric variables such as cloud base height, cloud profile and aerosol structure. Improved technology makes the MPL system an eye-safe, reliable, small, sensitive and efficient detection device for use in several commercial applications. NASA is seeking commercial partners to license this technology.

MPL is a conventional, time-gated, incoherent detection system designed specifically to address limitations of current lidar systems. The MPL system uses an optical Cassegrain telescope to transmit and expand outbound diode-pumped laser pulses. Low-pulse energies of ones or tens of microjoules are sufficiently expanded using the telescope with the appropriate diameter

to create eye-safe conditions. Light that is backscattered from the atmosphere is then returned to the telescope and separated from the transmitted pulses by passive polarization optics. By knowing the speed of light, the MPL system converts the time of flight into altitude and the number of photons counted for each altitude related to atmospheric scattering. Incoming signals are a few photons per microsecond or less, which require quantum noise limited detectors. The Geiger mode avalanche photodiode (GAPD) detector is used in NASA Goddard's MPL system for photon-counting signal detection and characterized by high quantum efficiency of near 70 percent in the 520 nm to 530 nm range. In

(continued on page 36)



NASA TECHNOLOGY OPPORTUNITIES FOR PRIVATE COMPANIES

Energy-Absorbing Protective Shroud

Developed at NASA's Johnson Space Center, the energy-absorbing protective shroud may be used to retain fragments from any high-speed machinery failure.

NASA is seeking commercial partners to license the energy-absorbing protective shroud. A dangerous situation occurs when the rotating components of high-speed machinery fail. The resulting fragments endanger the people and equipment close by. For example, modern aircraft engines contain rotating fan, compressor and turbine parts that can fail. Though rare, failures can be catastrophic. High-energy fragments have the potential to damage other aircraft components, such as adjacent engines and hydraulic control lines. In addition, the lives of the passengers and crew are directly endangered if the high-energy fragments enter the fuselage.

The subject technology is a light-weight containment shield that prevents fragments from escaping and dissipates, in a controlled manner, kinetic energy associated with the fragments. The protective-barrier system of the subject technology consists of the energy-transfer system, energy-dissipating system and encapsulating shell.

Beyond its primary uses in aircraft engines and gas turbines, including microturbines and combined-cycle power plants, the subject technology is easily adaptable to a variety of secondary applications. These applications include gyroscopes, centrifuges, transmissions, aviation cargo holds, engine test cells and explosives removal.

(continued on page 36)

Innovative Research

Putting Government Funding to Work

Advanced Ceramics Research (ACR) in Tucson, Ariz., credits new applications for technology as the company's key to growth. With the help of NASA's SBIR program, ACR is on the road to success.

What began with only \$1,000 in startup funds has since become a world-class company that focuses on developing state-of-the-art high-temperature, high-strength ceramic materials and processes.

Advanced Ceramics Research (ACR) is just the kind of company that NASA Langley's Small Business Partnership Team (SBPT) likes to cite as a successful product of the Small Business Innovation Research (SBIR) program.

CEO Mark Angier and President Anthony Mulligan founded the

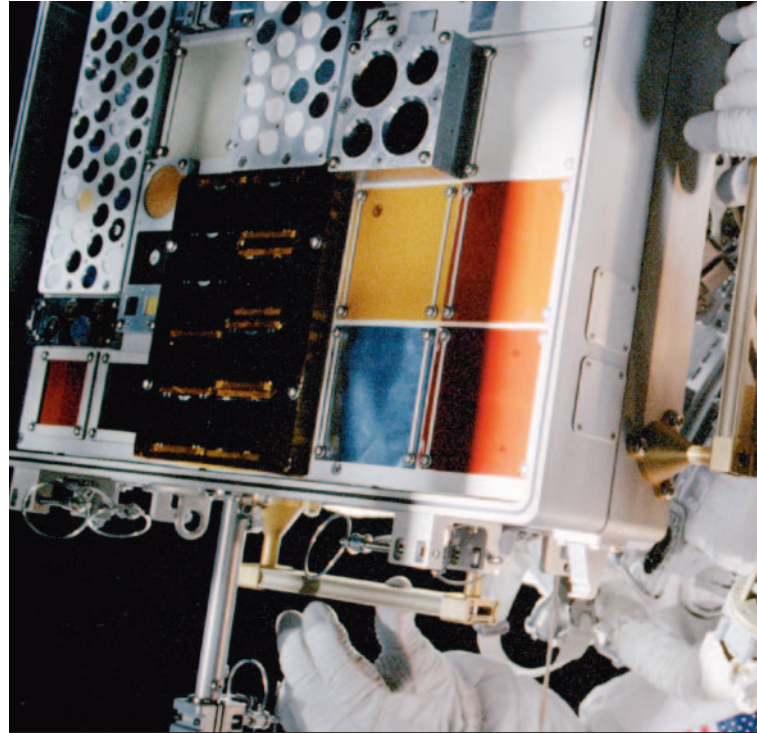
company in 1989. In the late 1990s, ACR received an SBIR award from NASA's Marshall Space Flight Center to develop a rapid-prototyping technology that could produce new composite materials. At that time, Marshall was working on ceramic materials that would enable a new generation of low-cost propulsion components for NASA and the Department of Defense.

After completing the SBIR work with Marshall, ACR was searching for other potential applications for the technology. The researchers knew that

the most immediate applications were in the area of bio-implants and believed that the technology would work well with some of the advanced materials they had been developing.

"We thought the natural fit would be for high-strength polymers that could be used for bio-implants," says Ranji Vaidyanathan, manager of advanced materials for ACR.

By combining computer modeling and its own revolutionary materials, ACR developed an innovative product that may one day be used to create artificial bone grafts. Plasti-Bone is



SAMPLES OF THE RADIATION-SHIELDING MATERIALS BEING DEVELOPED BY ACR WERE TESTED IN THE MATERIALS INTERNATIONAL SPACE STATION EXPERIMENT (MISSE).

EXAMPLES OF HOW NASA IS WORKING WITH SMALL BUSINESSES



PHOTO CREDIT: NASA/LARC

Through SBIR funding from NASA Langley, ACR is now developing new technologies for radiation-shielding applications.

Dr. Sheila Thibeault of Langley's advanced materials and processing branch has been working closely with ACR. "The multifunctional radiation-shielding materials being developed by ACR under the SBIR program for NASA Langley are candidate structural materials for protecting humans and microelectronics from the hazards of radiation," Thibeault says. "The materials may be used on the international space station, the crew exploration vehicle, crew habitats and rovers."

In addition, the materials have potential for nonaerospace radiation-shielding applications, such as nuclear accelerators, nuclear power plants, nuclear submarines and medical

The company has also entered the field of unmanned aerial vehicles (UAV). Through an SBIR award from the Office of Naval Research, ACR has teamed with another firm to develop and deploy the "Silver Fox." The Silver Fox is a small tactical UAV that uses high-tech "eyes in the sky" camera technology to gather intelligence information while simultaneously relaying the images to a remote laptop on the ground.

ACR has also been involved with Langley's Small Unmanned Aerial Vehicle Laboratory (SUAVELab). "We've been working with them to help improve their ability to design and operate small UAVs for the military," says Mike Logan, head of SUAVELab. "We're also helping them to develop and field technologies which will help protect our troops overseas."

Besides the federal government,

ACR pursues commercial

applications for

its research.

Angier

believes that

licensing the

company's technologies

to other industries has been an important mechanism.

"What they'll be able to do with the technology, we would struggle to do ourselves. It would take us much longer to commercialize and to do

strong enough to support new bone growth but porous enough to be absorbed and replaced by the human body. The use of the rapid-prototyping technology is a major benefit, because it can quickly create the artificial custom-fit bone material. Plasti-Bone is now undergoing lab trials to gain approval from the U.S. Food and Drug Administration, a process the company believes will take three to five years.

Through SBIR funding from NASA Langley, ACR is now developing new technologies for radiation-shielding applications.

facilities administering radiation therapy. The work with Langley is yet another example of ACR spinning out a new application from the work originally begun with Marshall.

PHOTO CREDIT: NASA/LARC



SAMPLE AND CROSS-SECTION OF THE PLASTI-BONE. IT IS CURRENTLY UNDERGOING LAB TRIALS TO GAIN APPROVAL FROM THE FDA.

the product development they're capable of, and they have marketing clout that a small business like ACR doesn't," Angier says.

The company has also signed a 10-year, multimillion-dollar license agreement, allowing a U.S. company to use one of ACR's technologies to improve the efficiency of oil and rock drilling. ACR has also expanded to international markets. One of its technologies has been licensed to Kyocera in Japan, the global leader in ceramics for communications applications.

ACR extends its partnerships to the academic community as well. From the beginning, the firm has collaborated with colleges and universities, believing that academic partnerships are critical to its research-and-development success. Angier says that large universities

often have resources for technology development beyond those of ACR. By partnering with the universities, the company can advance the development of its own technologies. In addition to working with the faculty, ACR regularly employs university interns on staff. The firm gets to "test drive" potential full-time employees before hiring them, and then has a close connection with the universities doing some of the technology transfer.

With product demand on the increase, ACR recently entered into a new joint venture called Advanced Ceramics Manufacturing, or ACM. The company was looking for ways to expand and help the community, and also develop a relationship that would be mutually beneficial. Through a cooperative arrangement, the owners of ACR are building a

new facility on the nearby Tohono O'odoom reservation. ACR will train people on the reservation to fill technical positions at ACM, with a focus on product development and manufacturing of ceramic tooling.

Angier believes federal funding is responsible for the technical superiority his company has today. But, it's more than that. ACR knows how to put its government funding to work by constantly searching for those new applications and opportunities. ■

For more information, contact Robert L. Yang, Manager, SBIR/STTR Program Office, NASA Langley Research Center, 757/864-8020, Robert.L.Yang@nasa.gov.

Please mention that you read about it in Technology Innovation.

Improving the Commercialization Process

The NASA Alliance for Small Business Opportunity (NASBO) outlines best practices for commercialization

A new pilot program for NASA Small Business Innovation Research (SBIR) Phase II companies outlines a body of technology commercialization best practices and will help to improve the commercialization process.

The NASA Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) office, in response to recognized commercialization barriers, conceived NASA Alliance for Small Business Opportunity (NASBO). The current pilot phase is a means to identify and validate elements of a process capable of improving commercialization rates, specifically the transition from Phase II to III. The pilot program is being conducted in Southern California by the NASA Commercialization Center. The intent is to demonstrate outcomes that make it attractive for chapters to form across the country.

In January 2003, nine companies that had applied were accepted into the NASBO pilot program based

primarily on commercialization potential. Commercialization is defined broadly as encompassing both spin-in (infusion into a NASA program) and spin-out (development for nongovernment markets). As a pilot program, NASBO is supporting commercialization efforts from ideation to prototype testing and validation.

The NASBO work suggests that effective ideation for an SBIR Phase II company requires a number of preparation steps. Although they sound straightforward, these steps actually require a recharacterization of the technology. The work also suggests that, if the proper basis for ideations is not established, the most effective strategies of recognizing “random events” and spotting “solutions” are nearly impossible to implement. Successful new-product ideation requires a customer frame of reference as opposed to a purely technical mind-set. Even when an SBIR Phase II company has considerable technology-commercialization capacity, each new opportunity means a return to basics.

Ideation preparation guidelines for NASBO companies are proving to be effective as a starting point. They include populating a grid with the significant technical-performance characteristics on one axis, and competing technologies or different approaches of the same technology on the other axis. This is an exercise that contrasts all competitive technologies.

The guidelines also include populating a grid with the top products under consideration in each market on one axis, and the dominant product features and benefits on the other axis. There should be at least one spin-in and one spin-out example developed. The strongest grids include the following features/benefits: product cost, market share, technology used, superior feature/benefit, and significant feature/benefit weakness. The spin-in grid should also include the readiness levels of the technology.

The information should be used to characterize a potential product, as if a discussion is being held with an informed customer who knows exactly what solutions are available in the marketplace.

The first attempt to complete the top three seemingly simple, straightforward tasks is proving to be more difficult to master and to take much longer than expected. However, the exercise has been effective in generating customer-focused discussions and orienting those involved to the framework of a commercialization culture. The result is greater confidence in the potential outcome and

more willingness to commit resources to the task.

The NASA Commercialization Center is a business incubator jointly developed by NASA and California Polytechnic State University, Pomona (Cal Poly Pomona). NASA, Southern California Edison and Cal Poly Pomona are sponsoring the NASBO pilot program. ■

For more information, contact Julie Holland, NASA Commercialization Center, 909/869-4477, jaholland@csupomona.edu.

Please mention that you read about it in Technology Innovation.

Micro-Pulse Lidar

(continued from page 30)

general, the MPL system can profile tropospheric aerosol and cirrus clouds with several seconds of integration time at night and several minutes during the day.

Possible commercial applications for the MPL system include atmospheric research, meteorological and environmental monitoring, and airport slant range visibility. ■

For more information, contact Ted Mecum, Goddard Space Flight Center, 301/286-5810.

Please mention that you read about it in Technology Innovation.

Energy-Absorbing Protective Shroud

(continued from page 31)

The subject technology offers several benefits. It is inexpensive, space efficient and able to accommodate machinery of virtually any geometric shape, and its materials are commonly available. The energy from the fragments is distributed in a fairly even manner, thus minimizing highly localized stress points in the energy-dissipating system.

The subject technology has potential disadvantages, including limiting access to the high-speed machinery and needing further testing to validate performance in the harsh conditions typically encountered in these in-service environments. ■

For more information, contact Ingrid Loy, National Technology Transfer Center, 800/678-6882.

Please mention that you read about it in Technology Innovation.



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NASA has established several organizations whose objectives are to establish joint-sponsored research agreements and incubate small startup companies with significant business promise.

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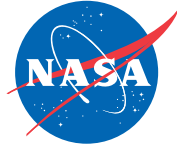
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